

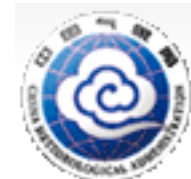
Data quality of FY-3 sounders and application in NWP

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National Satellite Meteorological Center, CMA

William Bell
ECMWF

Thanks to all who contributed to this work

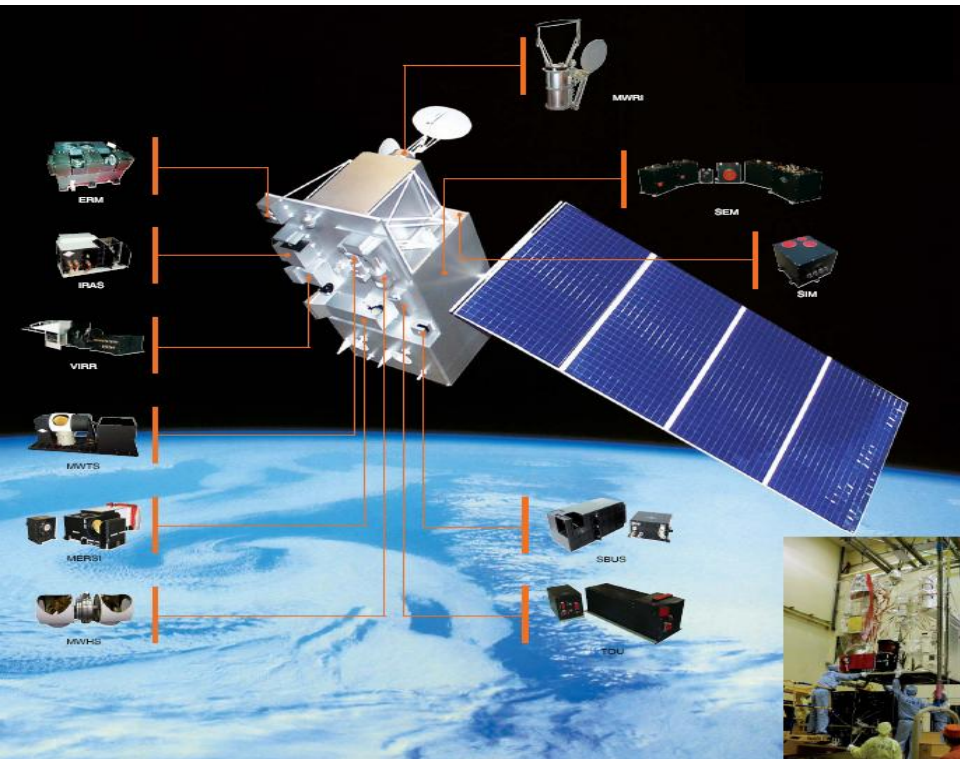


Outlines

1. Current status of FY-3 in NWP
2. FY-3A: Data quality; Bias correction; Forecast impact
3. FY-3B: Initial monitoring results



2nd Generation of LEO: FY-3



11 instruments on board FY-3A, including:

VIRR: Visible and Infra-Red Radiometer
MERIS: Medium Resolution Spectral Imager
IRAS: Infrared Atmospheric Sounder
MWTS: MicroWave Temperature Sounder
MWHS: MicroWave Humidity Sounder
MWRI: MicroWave Radiation Imager
SBUS: Solar Backscatter Ultraviolet Sounder
TOU: Total Ozone mapping Unit
SIM: Solar Irritation Monitor
ERM: Earth Radiation Monitor
SEM: Space Environment Monitor

Current status of FY-3A in NWP

- **CMA**

- **MWTS data Implemented into Chinese GRAPES system**

- **ECMWF**

- **Implemented into ECMWF IFS for VASS (MWTS, MWHS and IRAS) by clear-sky route and for MWRI by all-sky route**

- **Met Office and DWD**

- **Met Office and DWD are working on implementing FY-3A into Met Office UM system and DWD system**
- **FY-3A have been passively monitored from 3 Dec 2009**
- **The data have been operationally monitoring from CY37R1 update**



FY-3A Initial Assessment: Data Quality – Comparison with ATOVS & Aqua

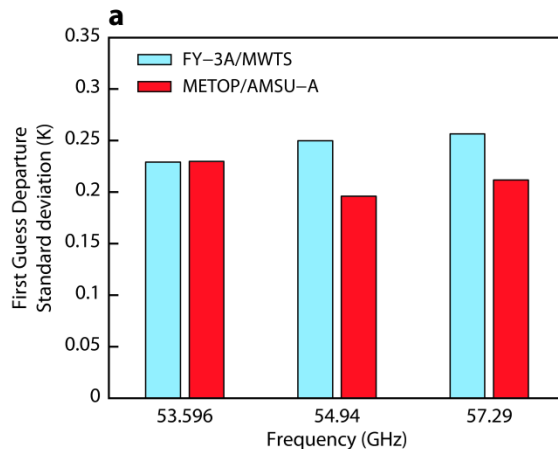
FY-3A data is comparable
with its counterpart

3 months experiment from 10 Aug to 1 nov 2008

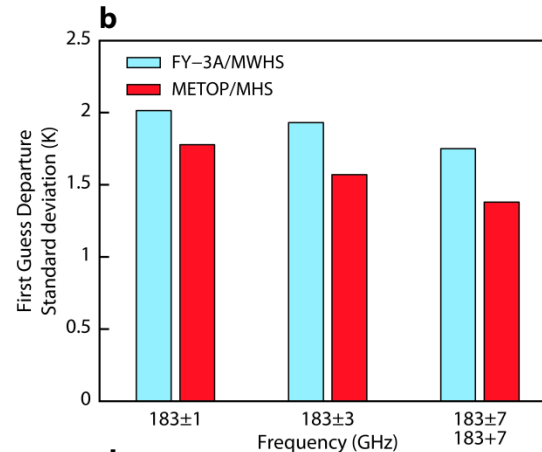
STDEV (first guess departures):

measures the misfit between model & measurement (in T_B space)

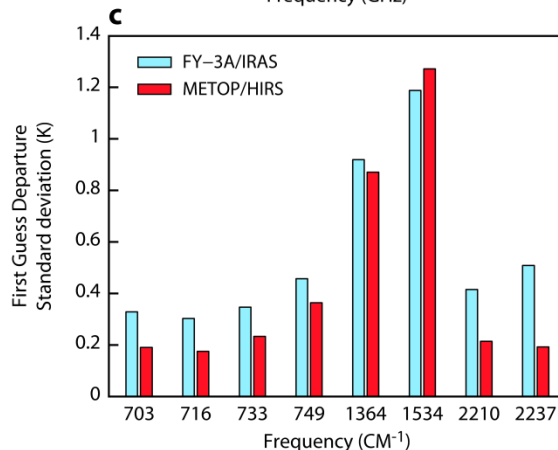
Microwave
Temperature
Sounder



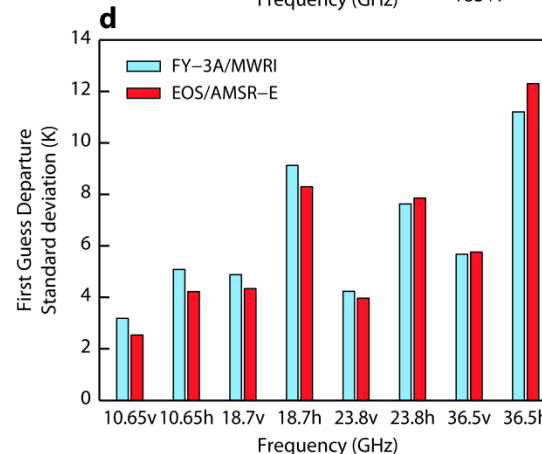
Microwave
Humidity
Sounder



Infrared
Sounder

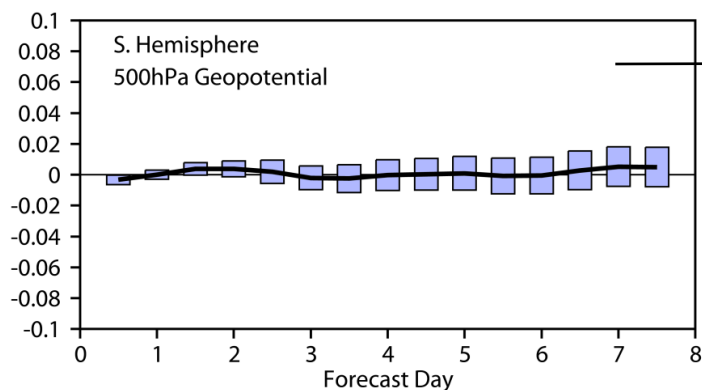
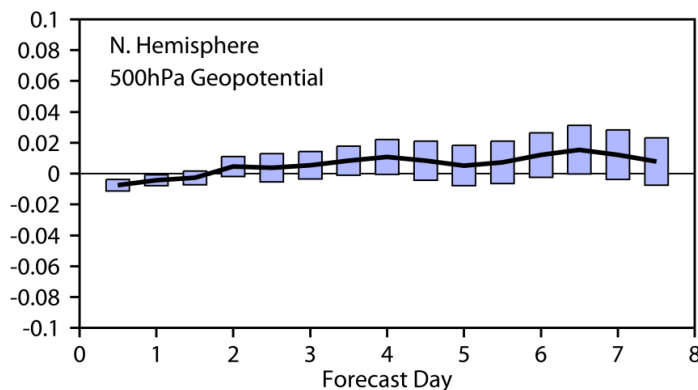


Microwave
Imager

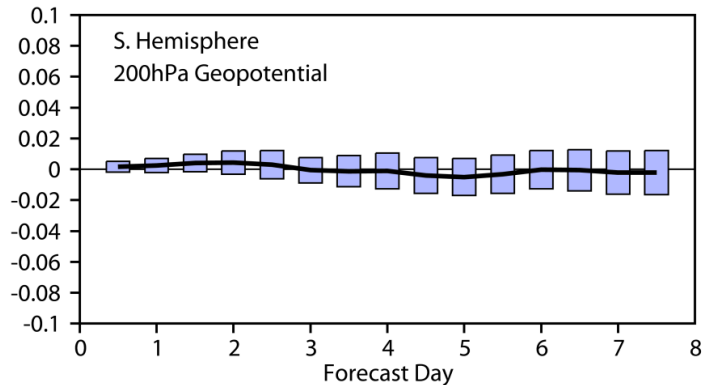
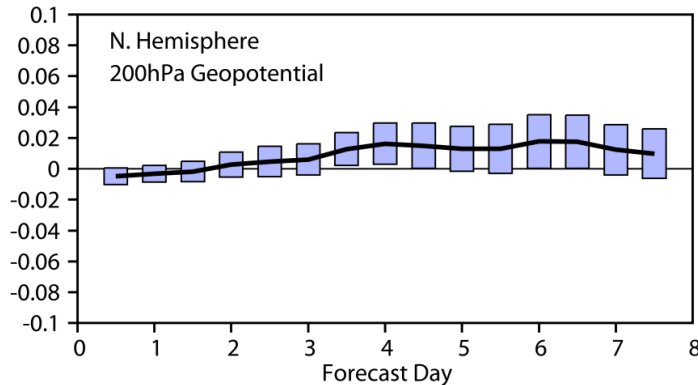


FY-3A Initial Assessment: Full System OSEs

The impact of the FY-3A data is neutral in SH and slightly positive in the NH



positive
impact
from FY-3A



Full System OSEs: ISS
Full System + FY-3A VASS suite (MWTS, MWHS, IRAS)
T511, 3 month experiment

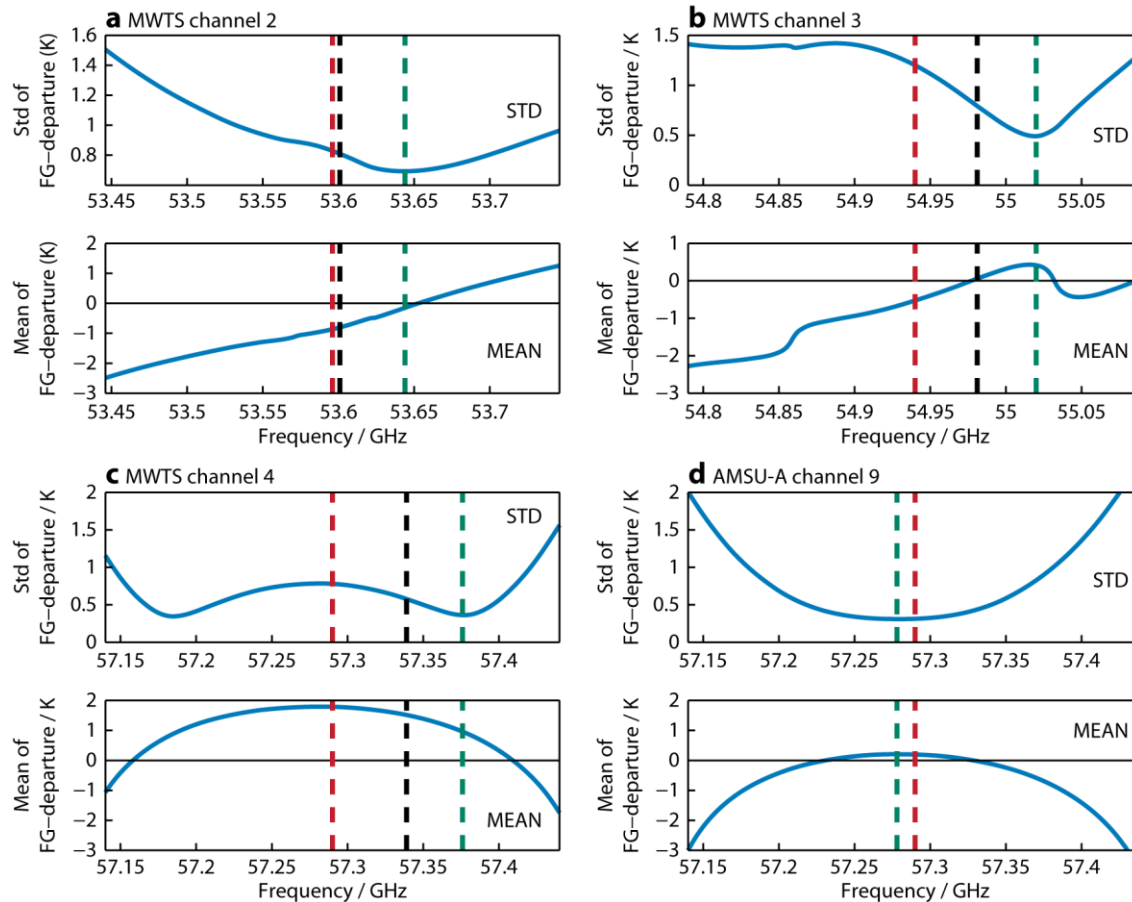


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Optimisation of MWTS Passband Centre Frequency Estimates



Pass band centres:

design spec.

measured

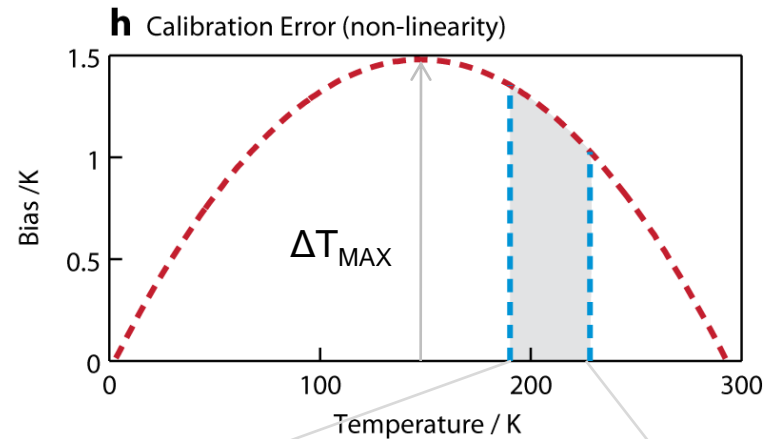
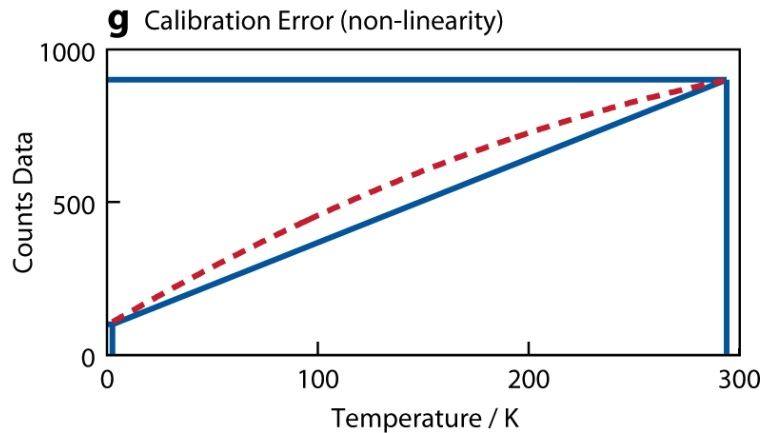
optimised

- Shifts are large !
30-55 MHz relative to pre-launch measurements

- Residual biases for ch 3 and 4

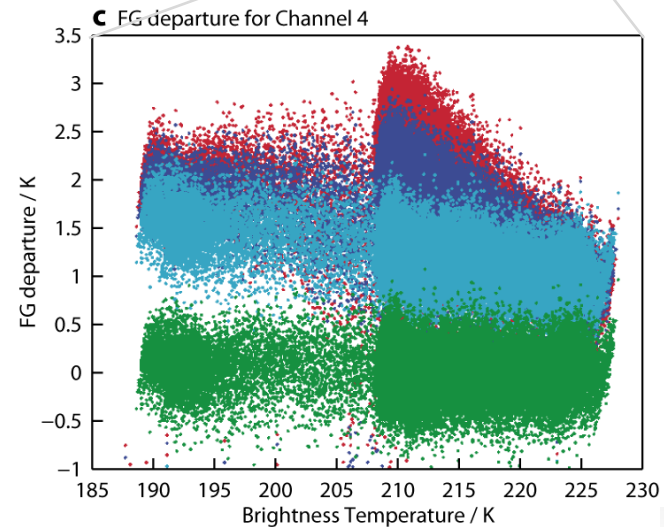


MWTS Radiometer Non-linearity



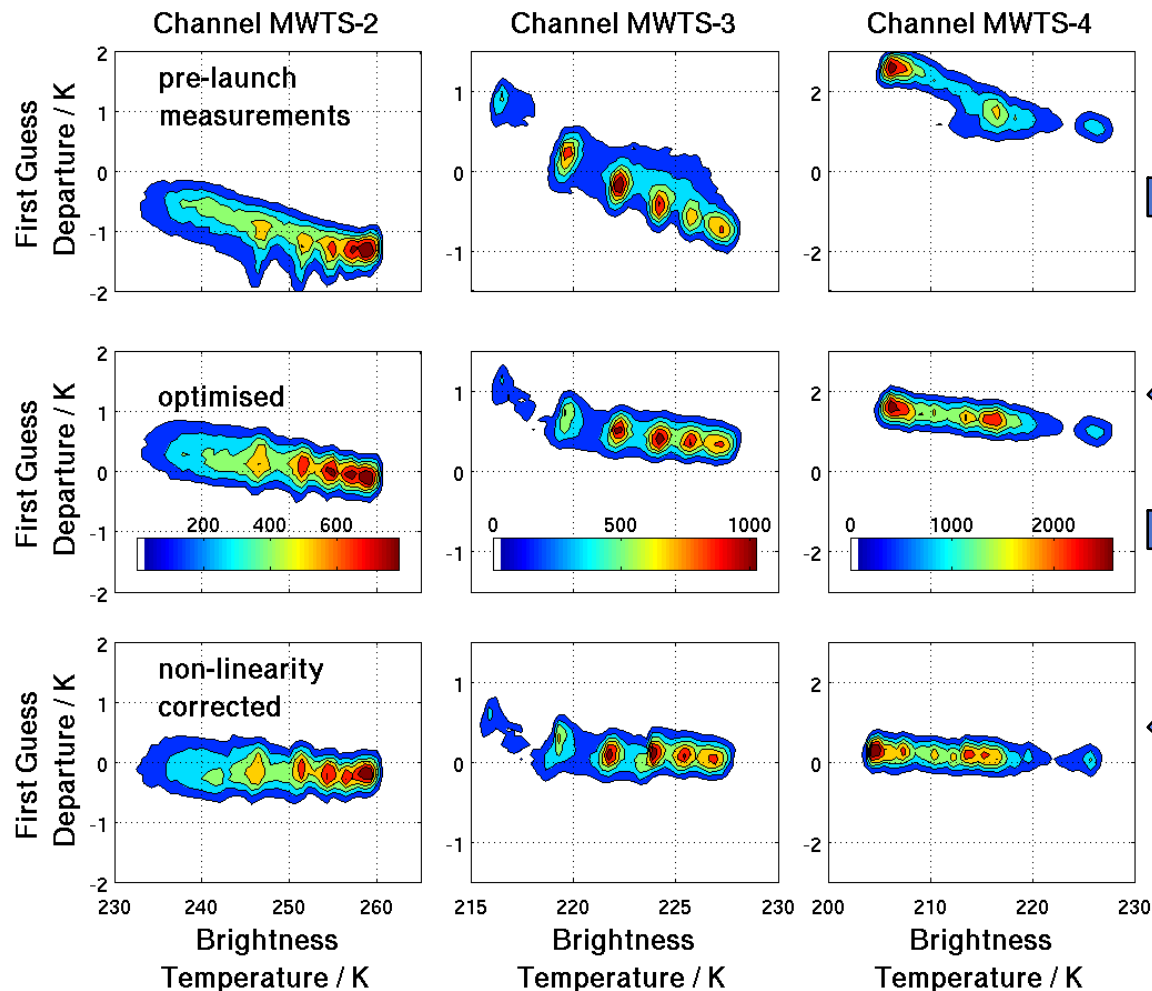
FIRST GUESS DEPARTURES

- design specified pass band
- pre-launch measured
- optimised
- non-linearity corrected



MWTS Radiometer Non-linearity

By correcting the passband shift and nonlinearity bias, the OMB Bias became more Gaussian distribution (i.e., around zero) 12d, 20100204-14



Adjust passband:
variance reduced

Corrected for
non-linearity:
leaves locally
unbiased data

MWTS-2

MWTS-3

MWTS-4

First Guess Departures (K)

12h, 20080914

Design specified passband

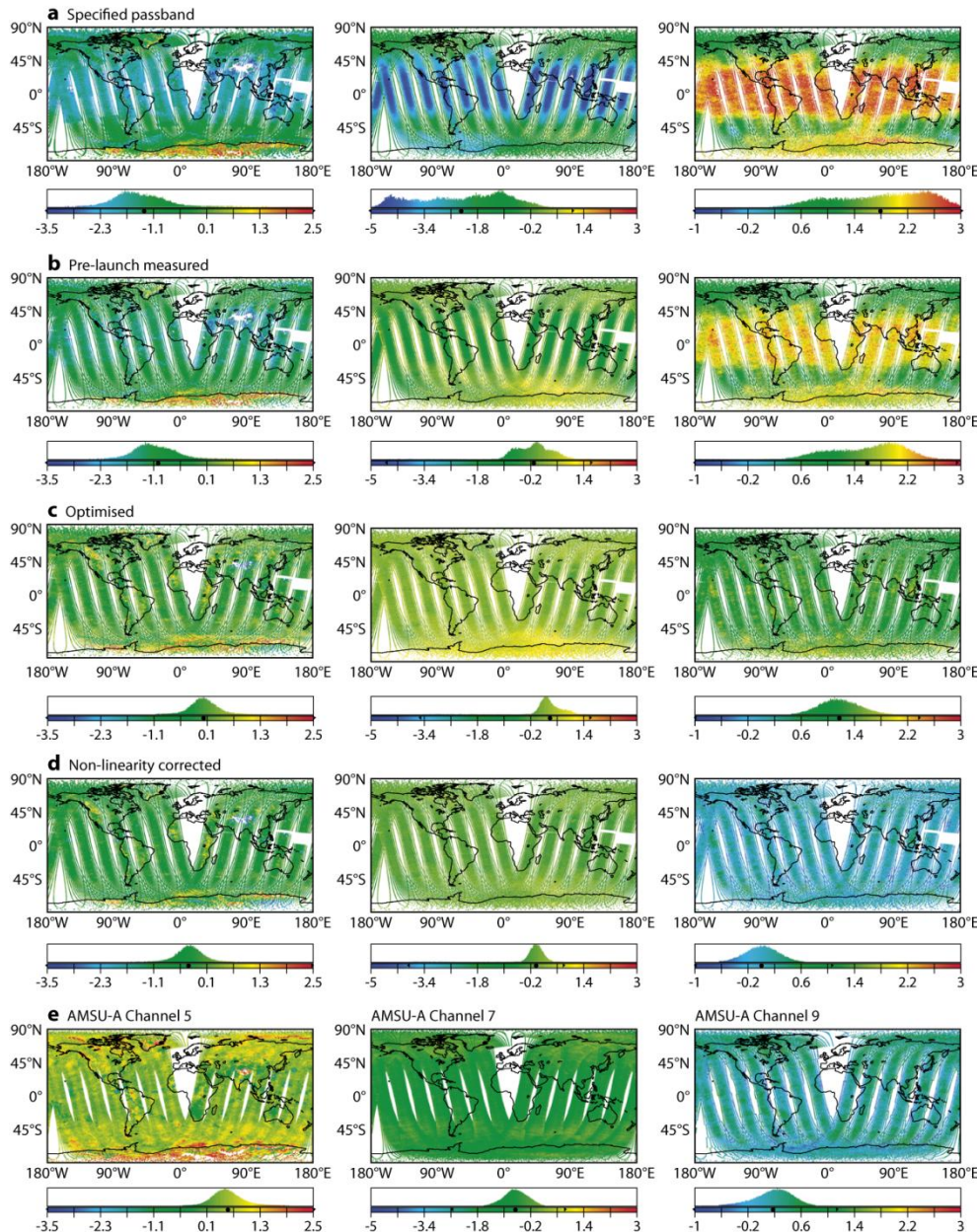
Pre-launch measured passband

Optimised passband

The improved Gaussian distribution is more clear

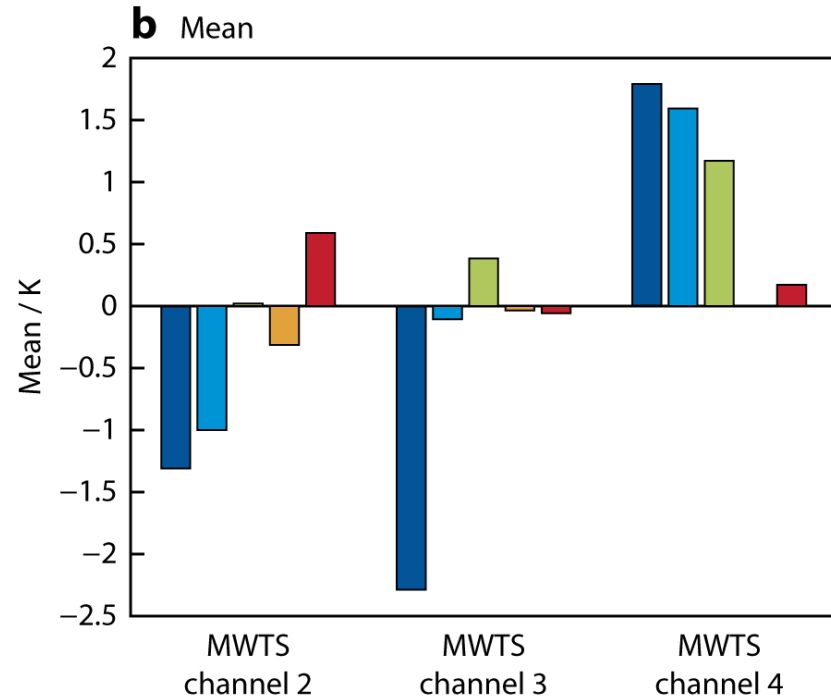
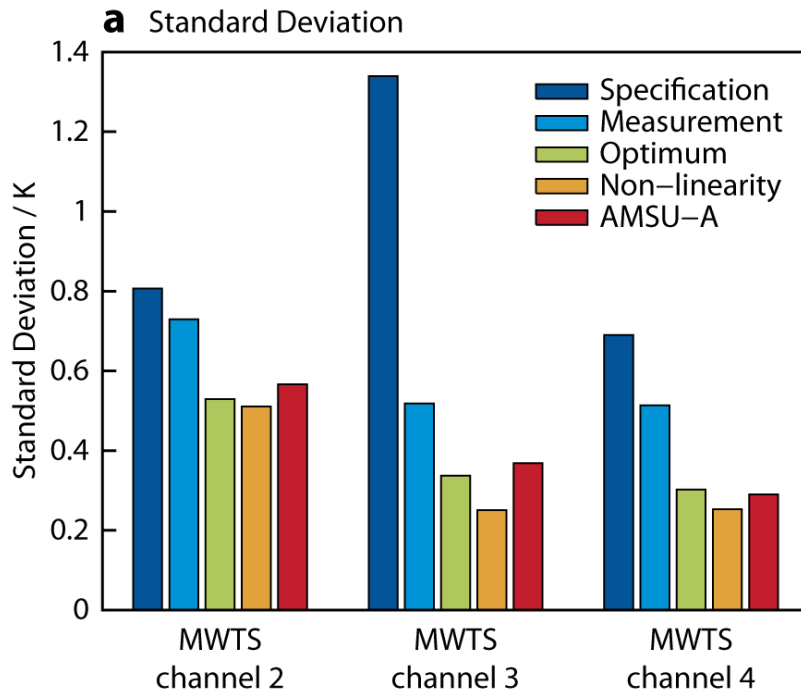
Non-linearity corrected

AMSU-A equivalent



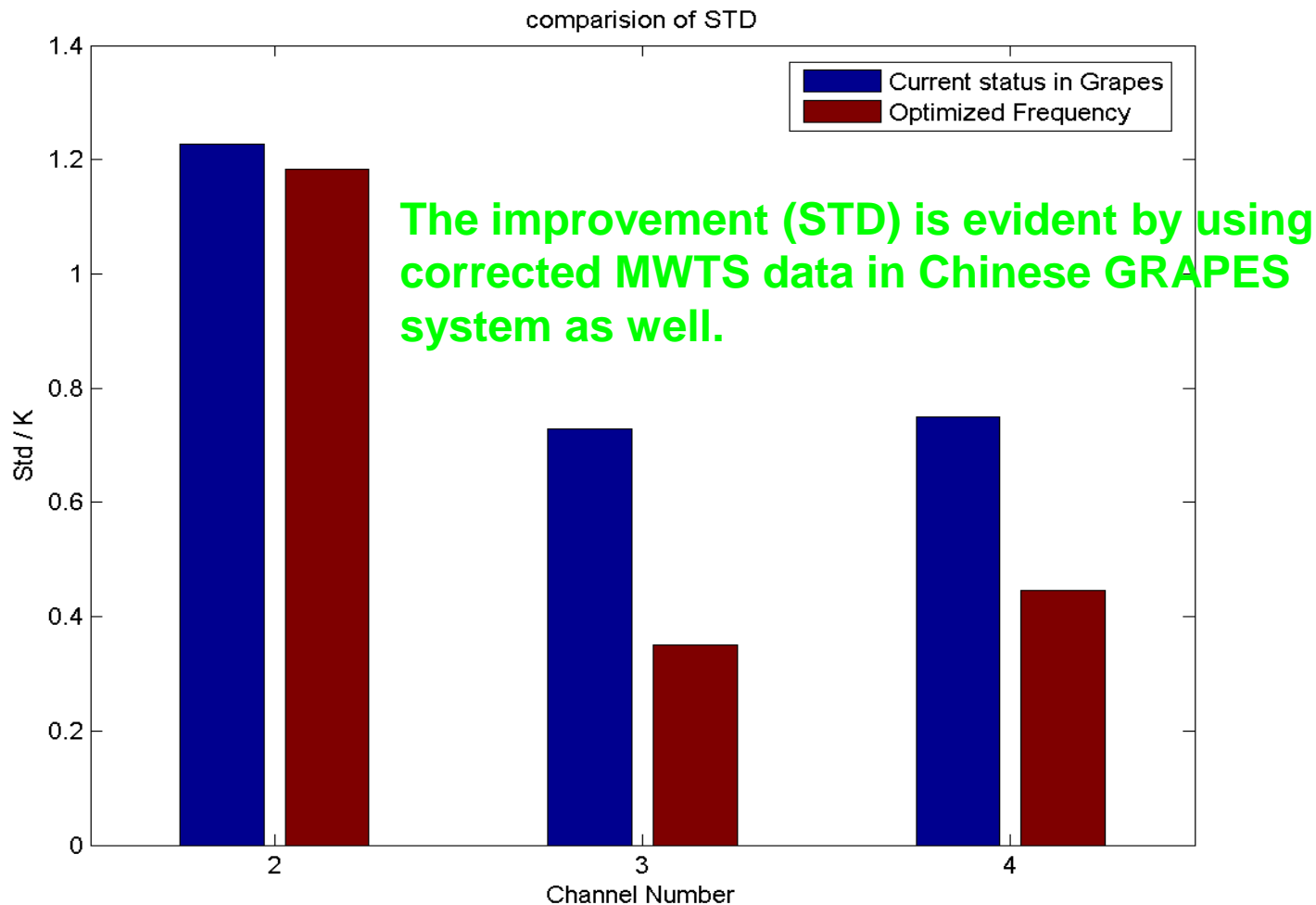
STD and Mean of First Guess Departure

The mean and Std of OMB is much improved and is really comparable with AMSU-A 12d, 20100204-14



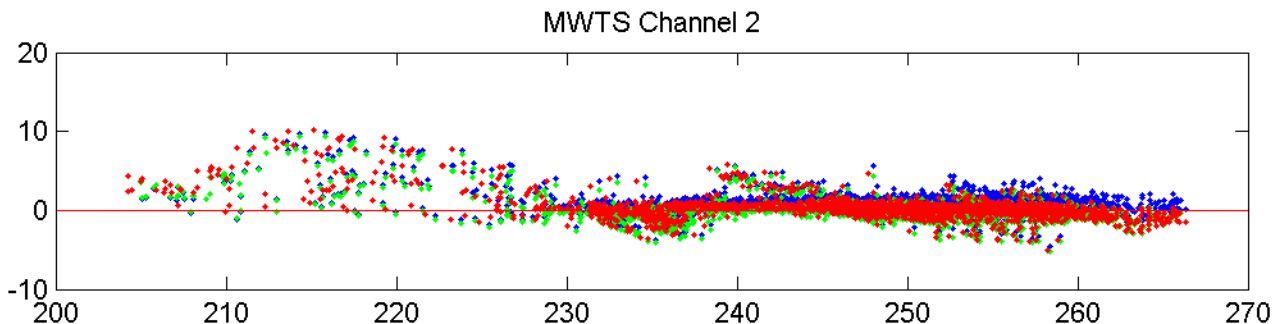
Characterizing the instrument systematic bias based on radiative transfer mechanism and calibration philosophy, independent on the ECMWF VarBC

STD Statistics of FY3A MWTS before and after bias correction in GRAPES system 20100908-18



Bias of FY3A MWTS before and after bias correction

20100908



In GRAPES

Prelaunch

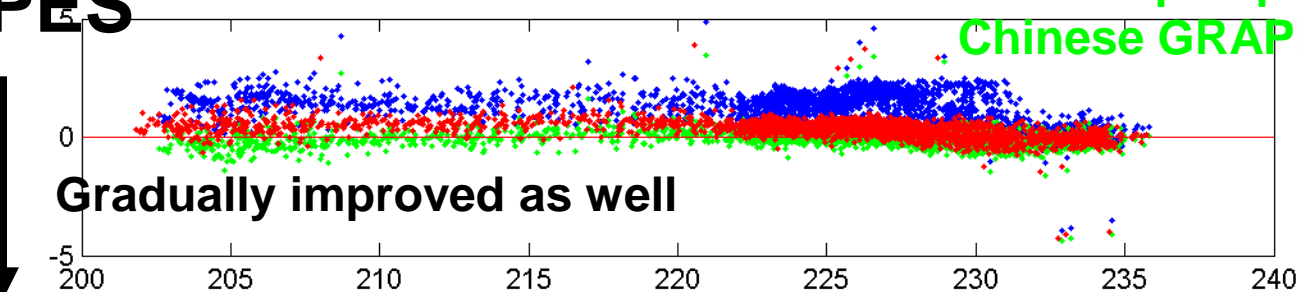
Optimize

NonL+Opt



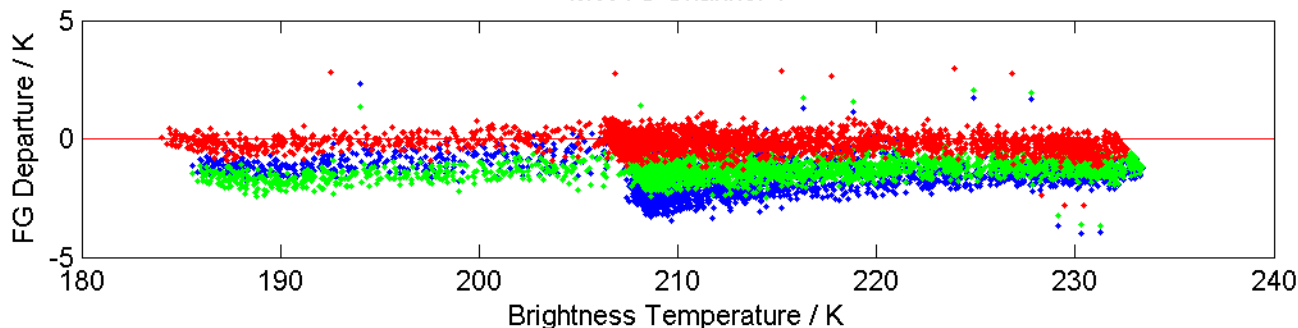
MWTS Channel 3

Gradually improved as well



Another perspective in
Chinese GRAPES system

MWTS Channel 4



MWTS: current status

Changes implemented at FENGYUN ground system March 2011

Statistics for RADIANCES from FY-3A/MWTS

Channel =4, All data [time step = 6 hours]

Area: lon_w= 0.0, lon_e= 360.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
EXP = 0001

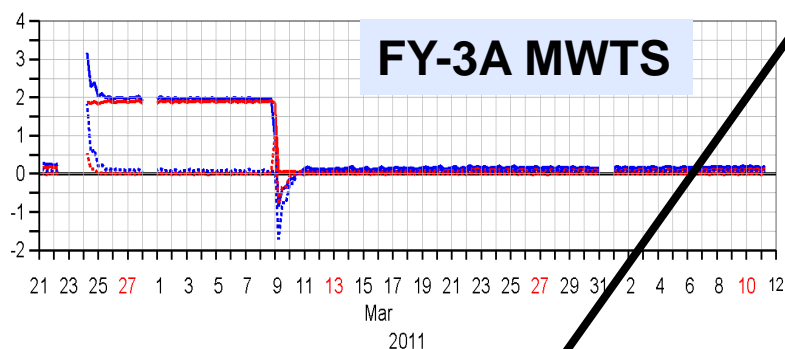
Statistics for RADIANCES from METOP-A/AMSUA (Global)

Channel =9, All data [time step = 6 hours]

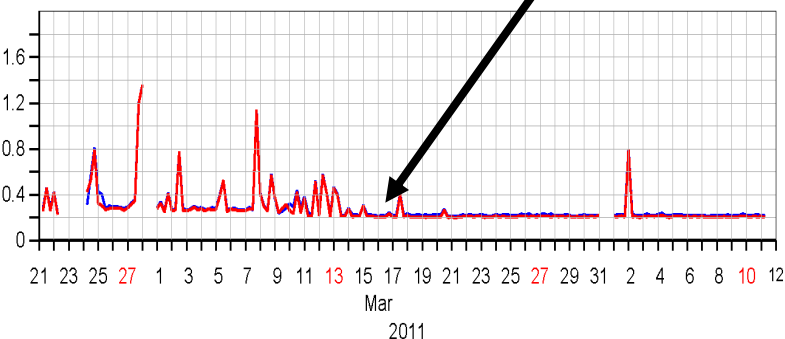
Area: lon_w= 0.0, lon_e= 360.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
EXP = 0001

— OBS-FG — OBS-AN OBS-FG(bcor) OBS-AN(bcor)

FY-3A MWTS

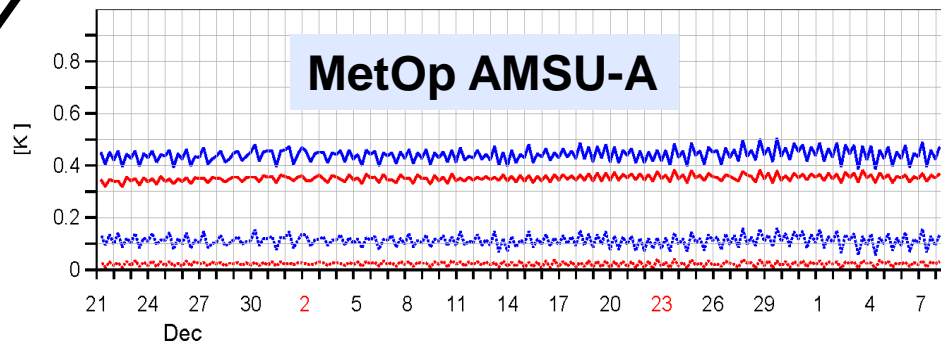


— stdv(OBS-FG) — stdv(OBS-AN)

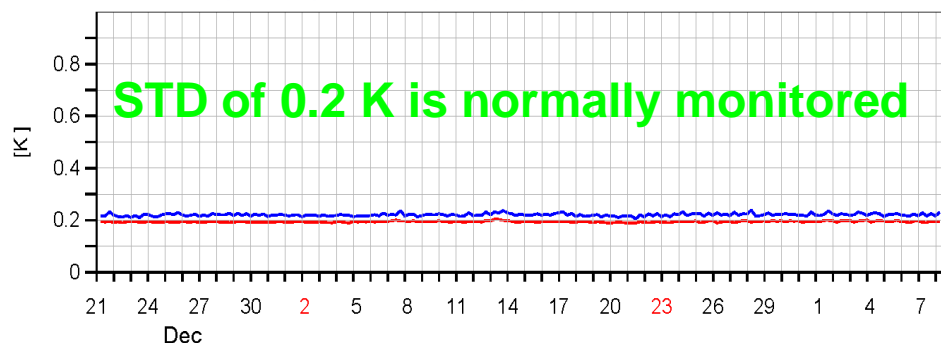


— OBS-FG — OBS-AN OBS-FG(bcor) OBS-AN(bcor)

MetOp AMSU-A



— stdv(OBS-FG) — stdv(OBS-AN)



STD of 0.2 K is normally monitored

MWTS Observing System Experiments

Forecast impact

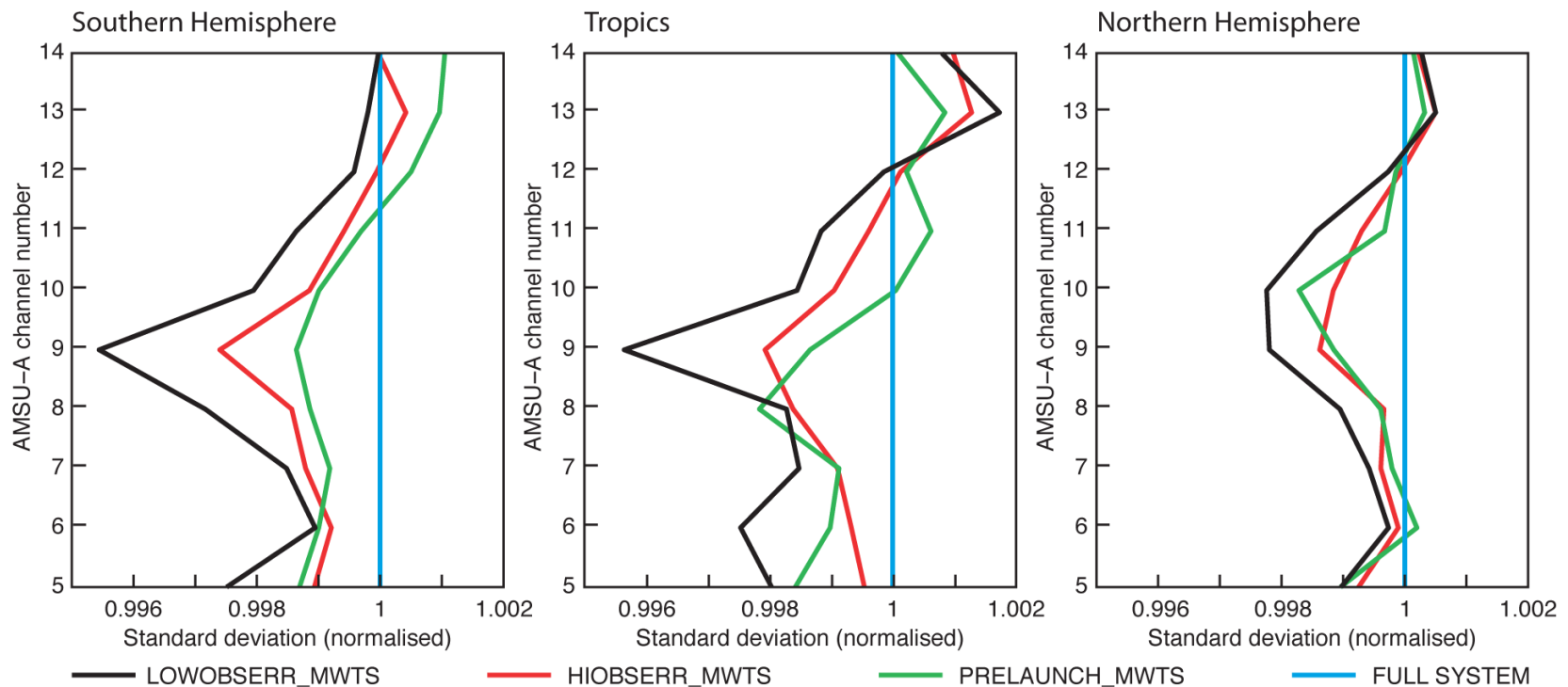
Identifier	Description	Assumed Observation Errors for MWTS-1/ -2/-3/ -4 (in Kelvin)
FULL_SYSTEM	Full Observing System	-
PRELAUNCH_MWTS	Full + Original MWTS data	10 / 0.43 / 0.52 / 0.55
HIOBSERR_MWTS	Full + recalibrated MWTS data with low weight	10 / 0.43 / 0.52 / 0.55
LOWOBSERR_MWTS	Full + recalibrated MWTS data with high weight	10 / 0.35 / 0.35 / 0.35

- 3 month experiments: May-July 2010
- T511 (~38 km grid resolution)



MWTS OSEs: First Guess fits to AMSU-A observations

Forecast impact



- 3-7 Million observations per channel aggregated over all 5 AMSU-A instruments.
- Up to 0.4% improvement in FG fits.

MWTS OSEs Forecast Verification: Z at 200, 500 and 700 hPa

Normalised differences in RMS
Errors in Z, verified against
own analysis
90% confidence intervals shown

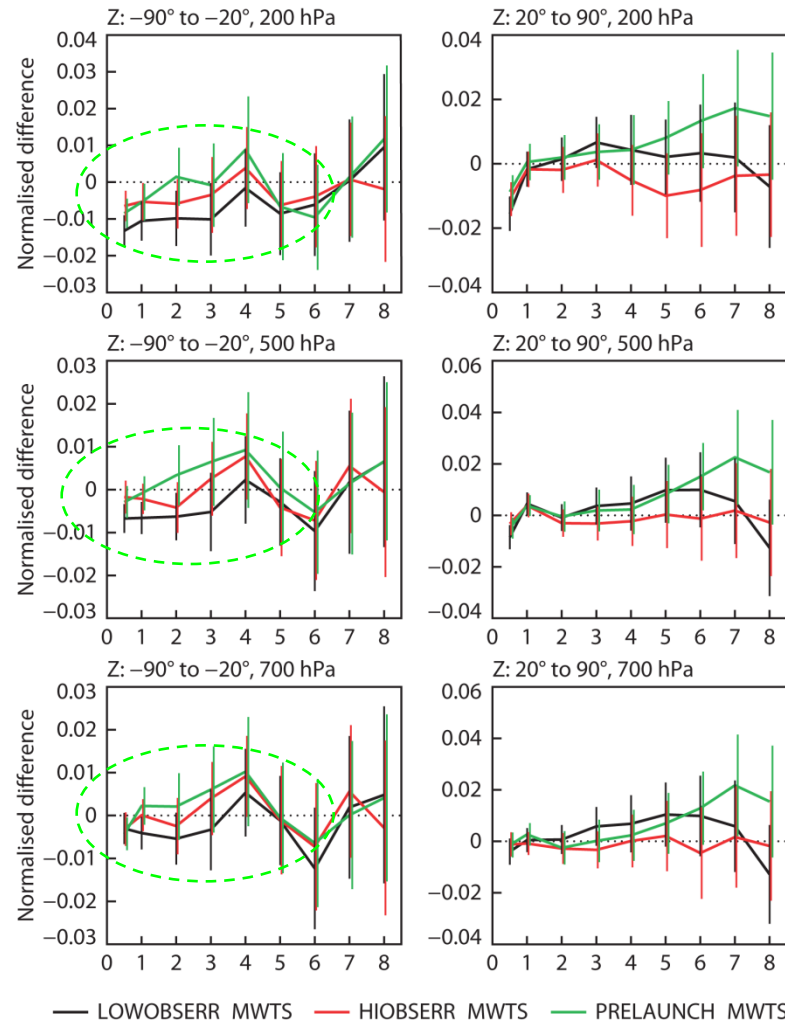
Small improvements
in SH in going from:

original data

→ recalibrated
(low weight)

→ recalibrated
(high weight)

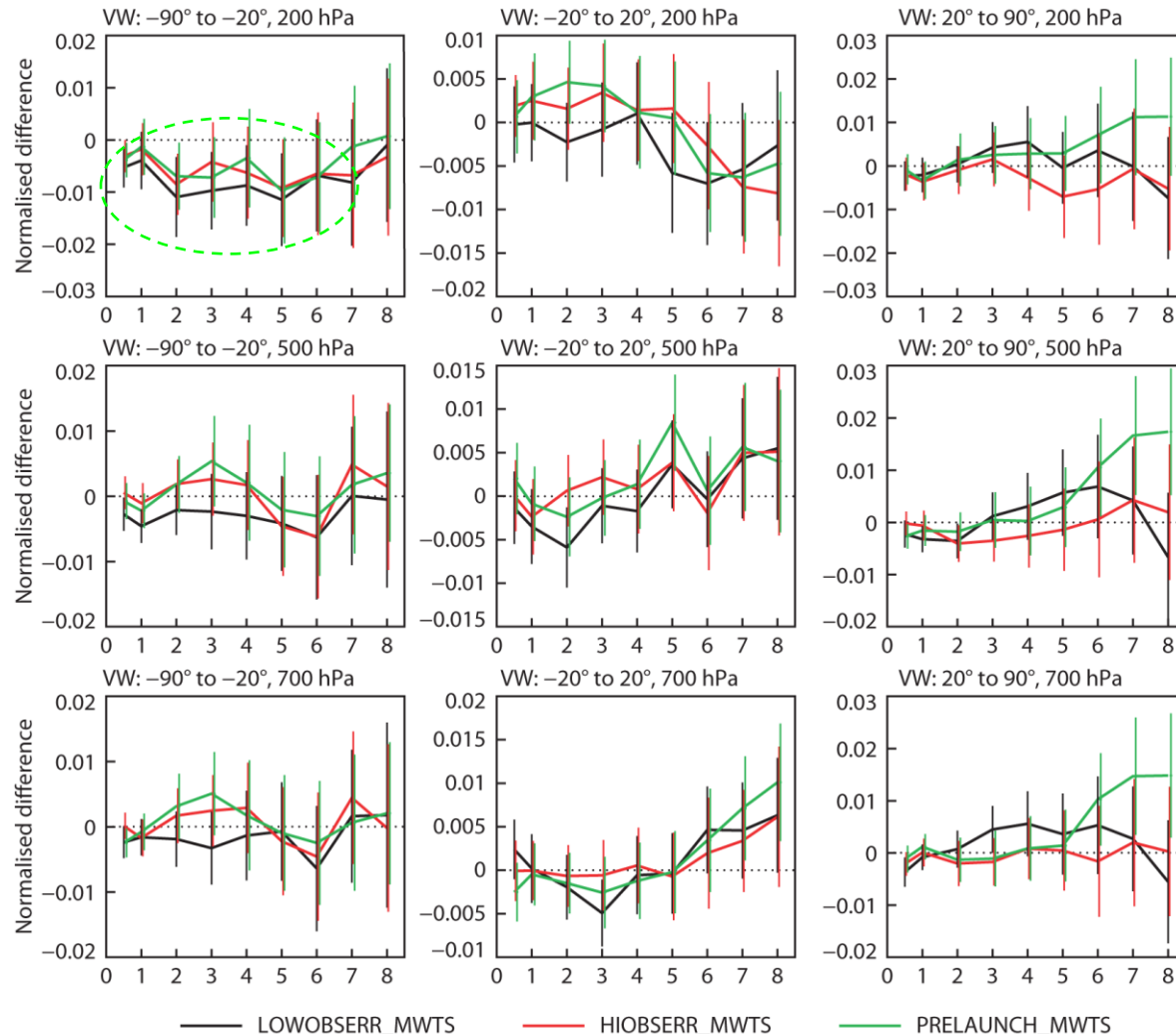
NH close to neutral
with some benefit
in recalibrated data



← Improvement
due to MWTS data



MWTS OSEs Forecast Verification: Winds at 200, 500 and 700 hPa



← Improvement
due to MWTS data

**Similar picture for
wind verification :**

- largest improvements
in SH 200 hPa winds.
- benefit of recalibration
evident in NH



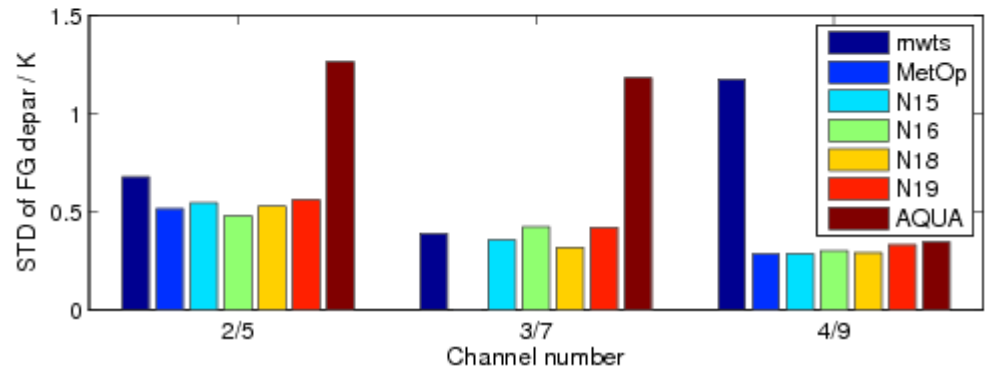
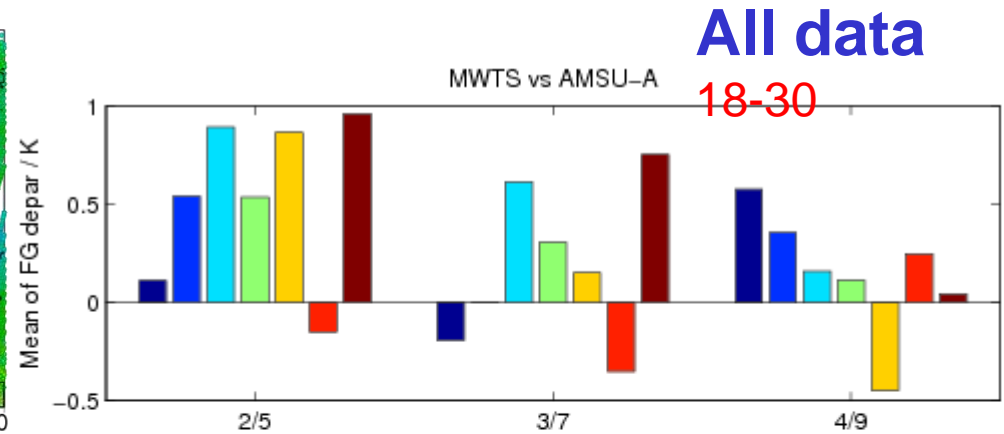
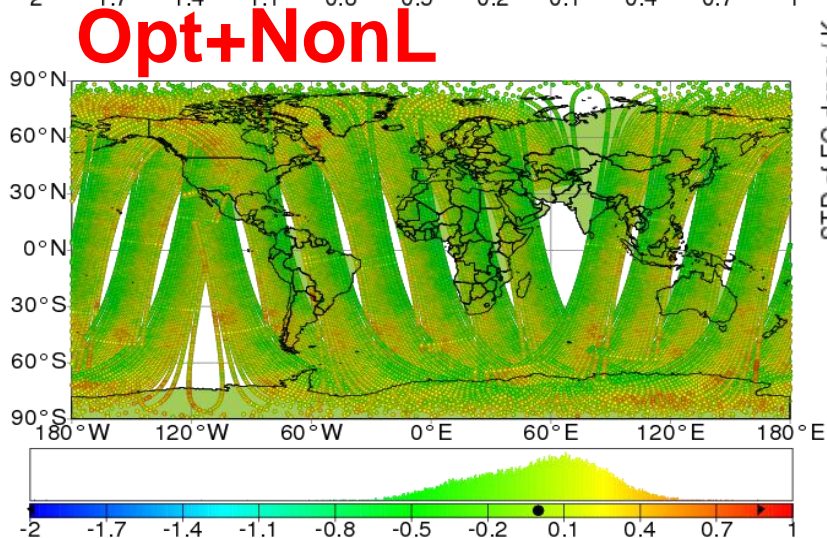
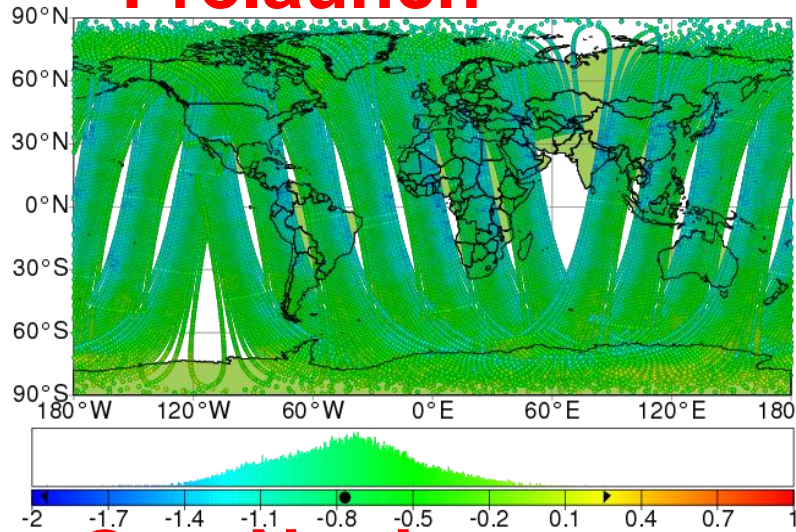
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3. FY-3B: Initial monitoring results



FY-3B: Pre-VarBC Bias statistics comparison

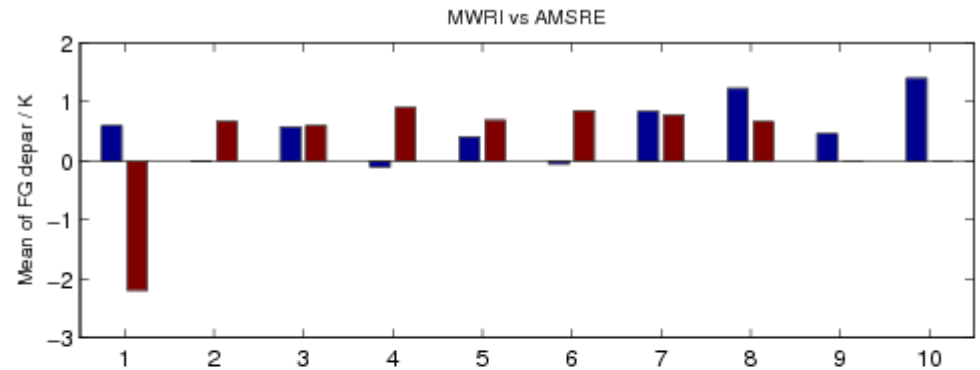
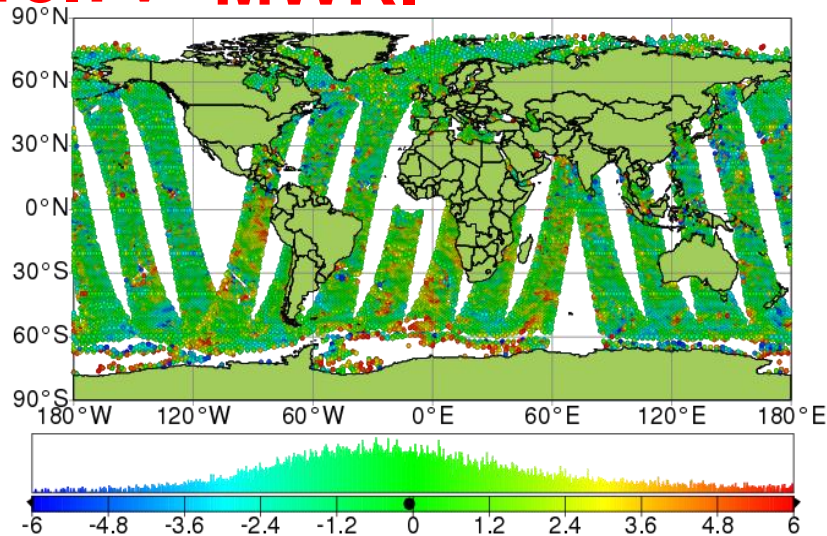
ch3
Prelaunch
MWTS vs AMSU-A 20110830



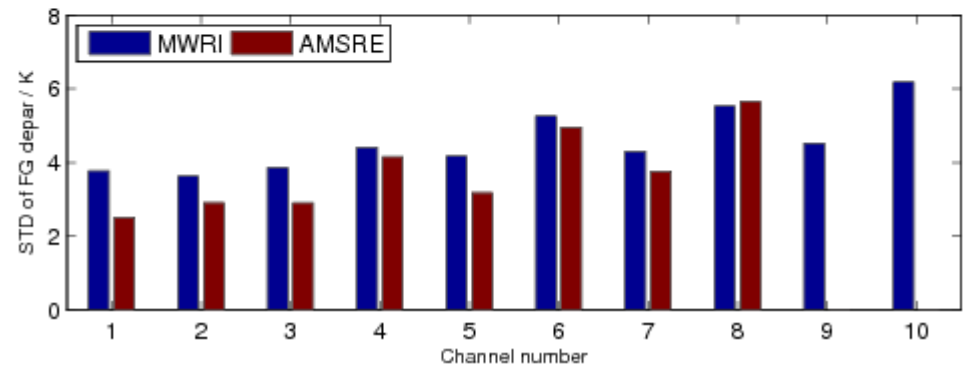
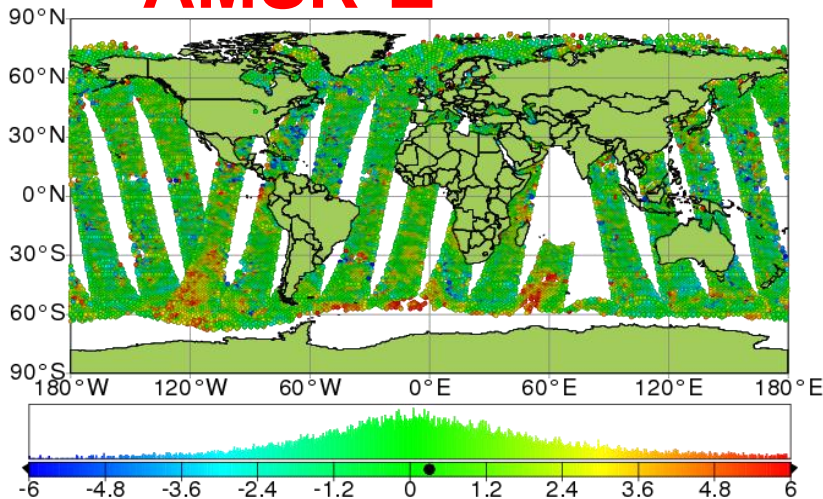
FY-3B: Pre-VarBC Bias statistics comparison

MWRI vs AMSR-E AQUA

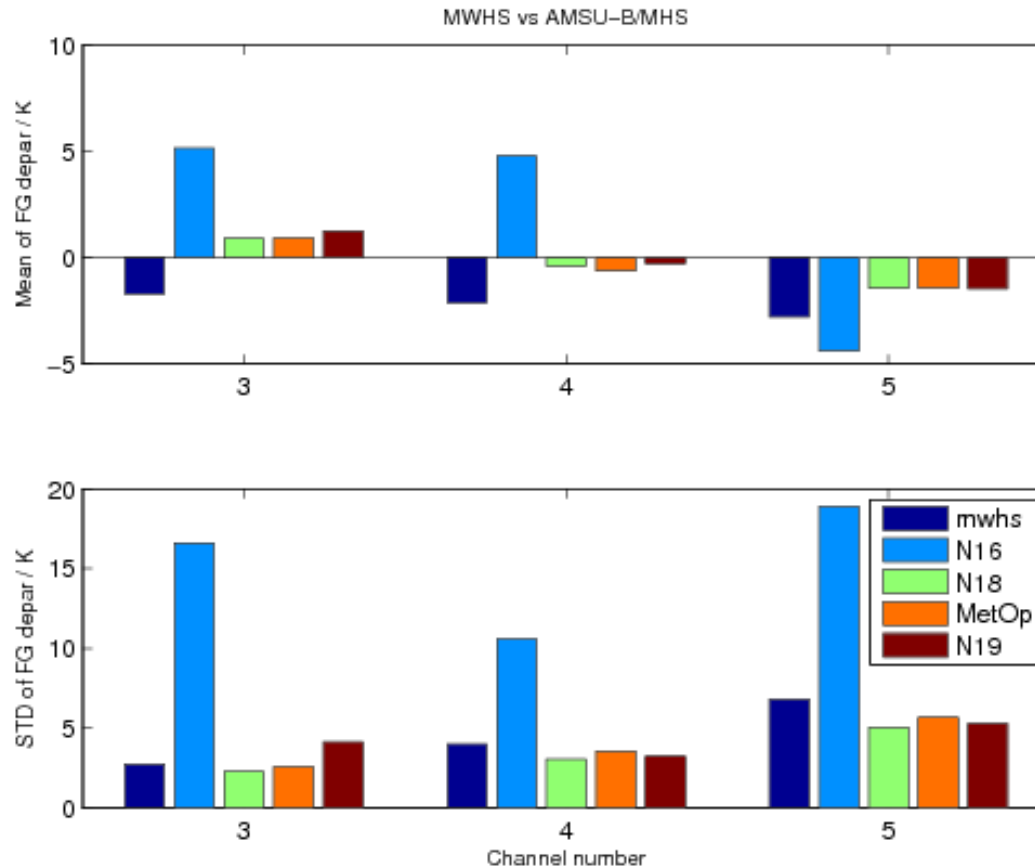
18.7v MWRI



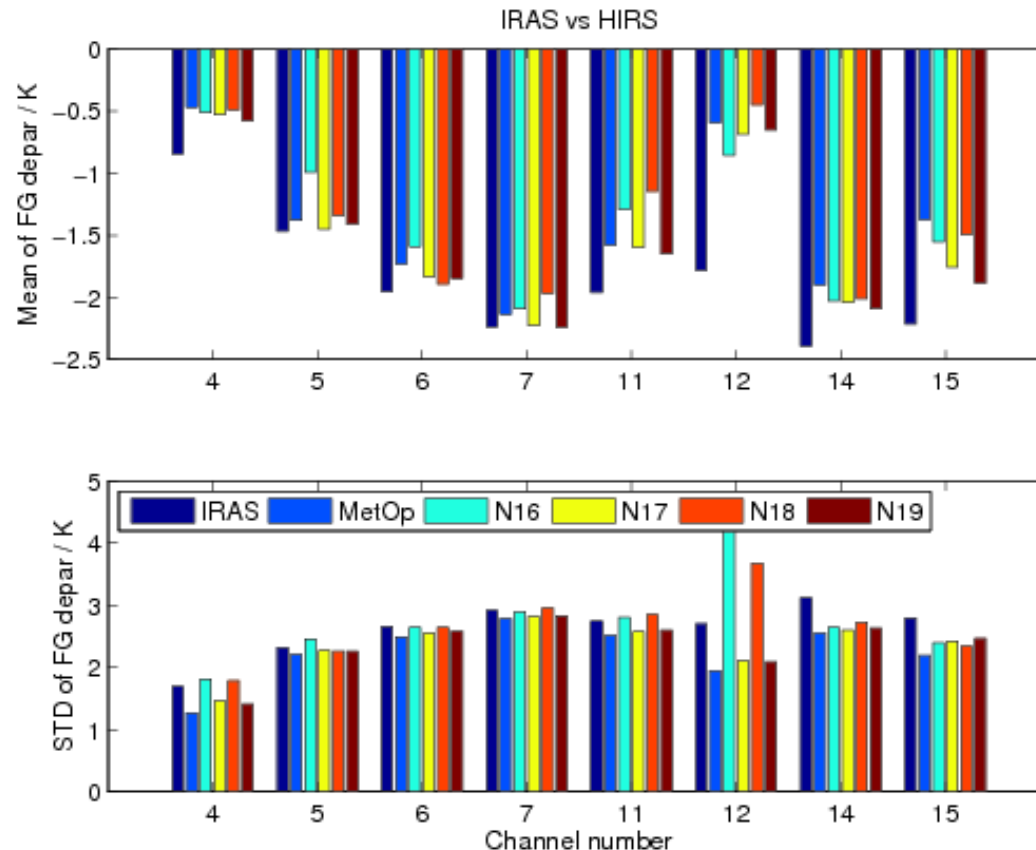
AMSR-E



FY-3B: Pre-VarBC Bias statistics comparison MWHS vs AMSU-B/MHS



FY-3B: Pre-VarBC Bias statistics comparison IRAS vs HIRS



Summary

- FY-3A data is of sufficiently good quality to proceed with observing system experiments and the impact of the FY-3A data is neutral in SH and slightly positive in the NH.
- Initial monitoring of FY-3B suggests the data is comparable with its counterpart.

Expecting further improving the FY-3 data quality and your interest in FY-3 data!



Publications

1. Qifeng Lu, et al , 2011. An evaluation of FY-3A satellite data for numerical weather prediction. ***Quarterly Journal of the Royal Meteorological Society***.
2. Qifeng Lu,et al. 2011. Improved assimilation of data from China's FY-3A microwave temperature sounder. ***Atmos. Sci. Let.***
wileyonlinelibrary.com, DOI: 10.1002/asl.354
3. Qifeng Lu et al. 2011. Characterising the FY-3A Microwave Temperature Sounder Using the ECMWF Model, ***American Meteorological Society***, 10.1175/JTECH-D-10-05008.1

Dr. LU Qifeng

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